

## **The role of experimental interdisciplinary inferences in assessing extinct minds**

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Experimental work is an important part of language evolution research across disciplines, as it allows for testing and producing theories. However, language originated in prehistoric times, and current evidence suggests that there were other species possessing language-like communication (e.g. Dediu & Levinson, 2018; Benítez-Burraco, 2025). Because we don't have direct access to extinct species who probably were the first to develop this type of communication, we must rely on experiments with extant ones. However, since no extant species can serve as a direct proxy for extinct ones, it is crucial to understand to what extent inferences from these experiments can be used to study the distant past and extinct species (Kuleshova & Pleyer, 2025).

Here, we evaluate the role of experimental interdisciplinary inferences in the field of language evolution. Namely, we assess the inferences made from experiments on extant species about the evolution of extinct ones in three major approaches in language evolution research: comparative psychology, cognitive archaeology, and experimental semiotics. For each approach, we first explain the overall methods they employ, then we summarize important inferences from experimental studies in these fields, and finally, we evaluate to what degree these inferences can be extended to characterizing the cognitive abilities of extinct hominins.

Comparative psychology investigates the cognitive differences and similarities between humans and non-human animals. With regard to language

evolution, experiments on non-human primates are often used to make inferences about earlier hominins and, most importantly, the cognitive abilities of our Last Common Ancestor (LCA). We review inferences drawn from experiments on tool use and toolmaking, as they share neurocognitive processes with human language (e.g. Greenfield, 1991; Thibault et al., 2021). These experiments also suggest that the cognitive abilities for social learning in our LCA were likely similar to those of chimpanzees and bonobos and were part of the evolutionary platform on which language evolved.

Cognitive archaeology studies human cognitive evolution through archaeological remains. We review stone tool reproduction experiments (e.g. Morgan et al., 2015) and neuroarchaeological experiments that aim to underpin the brain area activated during stone tool production (e.g. Putt et al., 2017). The results of neuroarchaeological experiments mostly align with the hypothesis of the co-evolution of toolmaking and linguistic capacities. For example, some studies report the involvement of parts of Broca's area (Uomini & Meyer, 2013; Brych et al., 2025). However, the results of experiments on different modes of stone tool-making teaching tend to agree that gestural teaching is at least as effective as linguistic instruction.

Experimental semiotics aims to recreate the emergence of communicative systems *de novo* in controlled laboratory settings (e.g. Galantucci et al., 2012; Nölle & Galantucci, 2023; Müller & Raviv, 2025). Inferences from this approach allow us to pinpoint the processes leading to the emergence of structured communication systems as well as the cognitive abilities and social conditions required for the emergence of linguistic structure (Delliponti et al., 2024).

Importantly, dialogue between these disciplines is hindered by epistemological differences due to different conceptualizations and operationalizations of key notions in language evolution research. If unresolved, these discrepancies might result in a dialogue where the parties are fundamentally talking past each other (Waciewicz et al., 2020). We discuss the epistemological commensurability of central concepts in all three approaches. Namely, we look at the concepts of *human*, *cognition*, *language*, *evolution*, and *culture* in order to understand possible points of convergence between them and thus lay common ground for future dialogue. We conclude that although not entirely incompatible, the three approaches need to communicate with each other more clearly on the often implicit definitions and might benefit from an explicit shared epistemological framework, such as the Extended Evolutionary Synthesis (EES), for example (e.g. Laland et al., 2015). In the EES, biological and cultural evolution are integrated into an interconnected loop, in which cultural behaviours both adapt to but also reshape environments, thereby influencing biological evolution in turn, in an ongoing feedback process.

Interestingly, we also find that despite epistemological differences, the three approaches discussed share similar limitations in their experiments, such as the absence of a real-world baseline or the impossibility of studying the targeted species directly, and more broadly WEIRD (Western, Educated, Rich and Democratic; Henrich, 2020) and BIZARRE (Barren, Institutional, Zoo, And other Rare Rearing Environments; Leavens et al., 2010) samples. We then discuss these challenges and the role of experimental work for interdisciplinary theory-building in language evolution research. We conclude that these considerations should be taken into account in future work, which should contain more explicit reflections on the epistemological compatibility of different approaches.

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